

## **4.0 RISK CHARACTERIZATION**

Risk was characterized by calculating ESQs and describing the main exposure pathways for receptors with an ESQ value above the DSHW ESQ target level of 1. The EcoRisk View output files were incorporated into the Access database, which was then queried to identify individual COPC–receptor combinations with equal diet and exclusive diet ESQ values exceeding the DSHW target level. The Access database is available electronically as Appendix D. It presents the complete list of COPC-specific ESQs for all habitats, receptors, and sources. The EcoRisk View output files are available electronically as Appendix E, as follows:

- Appendix E-1–Main EcoRisk View output file, which includes the results for all COPCs and receptors except for those noted below
- Appendix E-2–Dioxins/Fish TEF EcoRisk View output file (fish TEF values apply to community receptors)
- Appendix E-3–Dioxins/Bird TEF EcoRisk View output file
- Appendix E-4–PCBs/Fish TEF EcoRisk View output file
- Appendix E-5–PCBs/Mammal TEF EcoRisk View output file
- Appendix E-6–PCBs/Bird TEF EcoRisk View output file
- Appendix E-7–HPAH EcoRisk View output file

Spreadsheets listing COPC- and source-specific ESQs greater than the DSHW target level for each habitat are presented in Appendix F.

This section (1) presents the ESQ values exceeding the DSHW target level and describes potential risks, including the use of risk isopleths, (2) discusses potential impacts to habitats and receptors around the Jacobs Smelter Superfund site (in Stockton, Utah, north of DCD), and (3) discusses uncertainties.

### **4.1 ESTIMATION AND DESCRIPTION OF RISK**

Receptor-specific ESQs exceeding the DSHW target level are presented and evaluated to estimate the magnitude of risks. Both equal diet and exclusive diet ESQs are presented. In addition, ESQ values less than the DSHW target level are also presented and discussed to help describe the type of risk. Several types of ESQ values are presented, including:

- Source-specific ESQs determined for individual combustion units (e.g., TOCDF MPF) for specific receptors are presented to characterize potential risks associated with individual units at TOCDF and CAMDS.
- Facility-specific ESQs values were determined by summing receptor-specific ESQs across units specific to either TOCDF or CAMDS. These ESQs characterize potential facility-wide combustion risks based on the assumption that all units at a particular facility are operating concurrently.
- Grand total ESQs were determined by summing facility-specific ESQs for a specific receptor. These ESQs characterize risks based on the assumption that all units at both facilities are operating concurrently.

ESQs exceeding the DSHW target level were identified for receptors in the shrub-scrub habitat, Clover Pond, and Rush Lake; these risks are presented and discussed below. ESQ values for receptors in the montane habitat, Rainbow Reservoir, and Atherly Reservoir were less than 1, and are not discussed further.

#### **4.1.1 Shrub-Scrub Habitat**

DCD is situated in Rush Valley within the sage grass-salt shrub (shrub-scrub) habitat that dominates the valley floor. Animals commonly found on the valley floor include sage grouse, jackrabbit, pronghorn antelope, and birds of prey (see Figure 3-2). The Phase I ERA analysis indicated that three sources presented methylmercury ESQs for omnivorous birds (based on the American robin, an omnivore, as the measurement receptor) above the DSHW target level. The three sources include both of the LICs at TOCDF and the MPF at CAMDS (Table 4-1). The facility-specific and grand total (TOCDF + CAMDS) ESQs were similar. Source-specific methylmercury ESQs exceeding the DSHW target level were calculated for omnivorous birds assuming that terrestrial invertebrates compose one hundred percent of their diet. The ESQ values decreased to less than 1 when it was assumed that the omnivorous bird diet was 50 percent invertebrates and 50 percent plant matter. The ESQ values decreased to 0.01 when it was assumed that the diet was entirely plant matter. The differences in the magnitudes of the ESQs are a function of the propensity for mercury to accumulate, in terrestrial ecosystems, in animal matter rather than in plant matter.

#### **4.1.2 Clover Pond**

Clover Pond is an ephemeral water body outside the western boundary of DCD. It has been dry for more than two years. The Phase I ERA indicated that two sources at CAMDS—the MPF and DFS—presented

**TABLE 4-1****ESQ VALUES FOR SHRUB-SCRUB RECEPTORS EXCEEDING THE DSHW TARGET LEVEL**

Source	COPC	Measurement Receptor	Food Type	ESQ
TOCDF LIC 1	Methyl mercury	Omnivorous Birds	Terrestrial Invertebrates	1
TOCDF LIC 2	Methyl mercury	Omnivorous Birds	Terrestrial Invertebrates	1
CAMDS MPF	Methyl mercury	Omnivorous Mammals	Terrestrial Invertebrates	2
TOCDF	Methyl mercury	Omnivorous Birds	Terrestrial Invertebrates	3
			Equal Diet	1
CAMDS	Methyl mercury	Omnivorous Birds	Terrestrial Invertebrates	2
TOCDF + CAMDS	Methyl mercury	Omnivorous Birds	Terrestrial Invertebrates	4
			Equal Diet	2

**Notes:**

CAMDS      Chemical Agent Munitions Disposal System (all sources combined)  
 COPC      Compound of potential concern  
 DSHW      Division of Solid and Hazardous Waste  
 ESQ      Ecological screening quotient  
 LIC1      Liquid incinerator 1  
 LIC2      Liquid incinerator 2  
 MPF      Metal parts furnace  
 TOCDF      Tooele Chemical Agent Disposal Facility (all sources combined)

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methylmercury ESQs for omnivorous aquatic birds, carnivorous birds, and piscivorous birds (see Figure 3-4) that exceed an ESQ of one for Rush Lake (Table 4-2). In terms of facility-specific risks, both CAMDS and TOCDF presented methylmercury ESQs above the target level. Grand total ESQs displayed similar patterns. Exposure through algae ingestion was responsible for the magnitude of the omnivorous aquatic bird ESQs. The omnivorous aquatic bird equal diet ESQs, which are based on the ingestion of equal parts algae, benthic invertebrates, and rooted aquatic plants, were about one-third of the algae ESQs. The difference between the ESQs indicates that mercury dissolved in surface water, rather than that deposited in sediment, and its subsequent bioconcentration by algae, is the primary biotic transport pathway of concern for aquatic birds.

The source-specific ESQ values for carnivorous birds and piscivorous birds are based on the ingestion of carnivorous fish. The concentration of methylmercury in carnivorous fish depends on the concentration in surface water and its bioaccumulation by fish. These results also point to the relative importance of surface water-based exposure pathways for birds.

#### **4.1.3 Rush Lake**

Only grand total (all TOCDF sources plus all CAMDS sources) ESQs for VX for omnivorous aquatic mammals (see Figure 4-4) exceed an ESQ of one Rush Lake (Table 4-2). The ESQ values are less than 2.

#### **4.1.4 Risk Isopleths**

The exposure assessments for the terrestrial habitats were performed with EELs calculated using arithmetic average soil concentrations. Evaluation of the air dispersion modeling information indicates soil COPC concentrations decrease as a function of distance from any particular source at TOCDF and CAMDS. To characterize methylmercury risks as a function of distance from TOCDF and CAMDS, ESQ isopleths were created utilizing air concentrations and depositions modeled for each receptor node, rather than concentrations and depositions averaged over the shrub-scrub habitat. The isopleths were used to describe risks to omnivorous birds consuming terrestrial invertebrates, the pathway that presented the highest methylmercury ESQs for these receptors. Risks to receptors in aquatic food webs could not be described with isopleths because COPC inputs (e.g., air depositions and soil runoff) to surface water bodies are assumed to mix uniformly within the water column.

**TABLE 4-2**

**ESQ VALUES FOR AQUATIC RECEPTORS EXCEEDING THE DSHW TARGET LEVEL**

Source	COPC	Measurement Receptor	Food Type	ESQ
Clover Pond				
CAMDS DFS	Methylmercury	Omnivorous Birds	Algae	2
CAMDS MPF	Methylmercury	Omnivorous Birds	Algae	16
			Equal Diet	6
		Piscivorous Birds	Carnivorous Fish	1
			Planktivorous Fish	1
			Equal Diet	1
TOCDF	Methylmercury	Omnivorous Birds	Algae	2
CAMDS	Methylmercury	Omnivorous Birds	Algae	18
			Equal Diet	6
		Carnivorous Birds	Carnivorous Fish	2
		Piscivorous Birds	Carnivorous Fish	1
			Planktivorous Fish	1
			Equal Diet	1
TOCDF + CAMDS	Methylmercury	Omnivorous Birds	Algae	19
			Equal Diet	7
		Carnivorous Birds	Carnivorous Birds	2
		Piscivorous Birds	Carnivorous Fish	1
			Planktivorous Fish	1
			Equal Diet	1
Rush Lake				
TOCDF + CAMDS	VX	Omnivorous Mammals	Benthic Invertebrates	2
			Equal Diet	1
			Rooted Aquatic Plants	1

**Notes:**

CAMDS Chemical Agent Munitions Disposal System  
 COPC Compound of potential concern  
 DFS Deactivation furnace system  
 DSHW Division of Solid and Hazardous Waste  
 ESQ Ecological screening quotient  
 MPF Metal parts furnace  
 TOCDF Tooele Chemical Agent Disposal Facility  
 VX O-ethyl-S-[2-diisopropylaminoethyl] methylphosphonothiolate

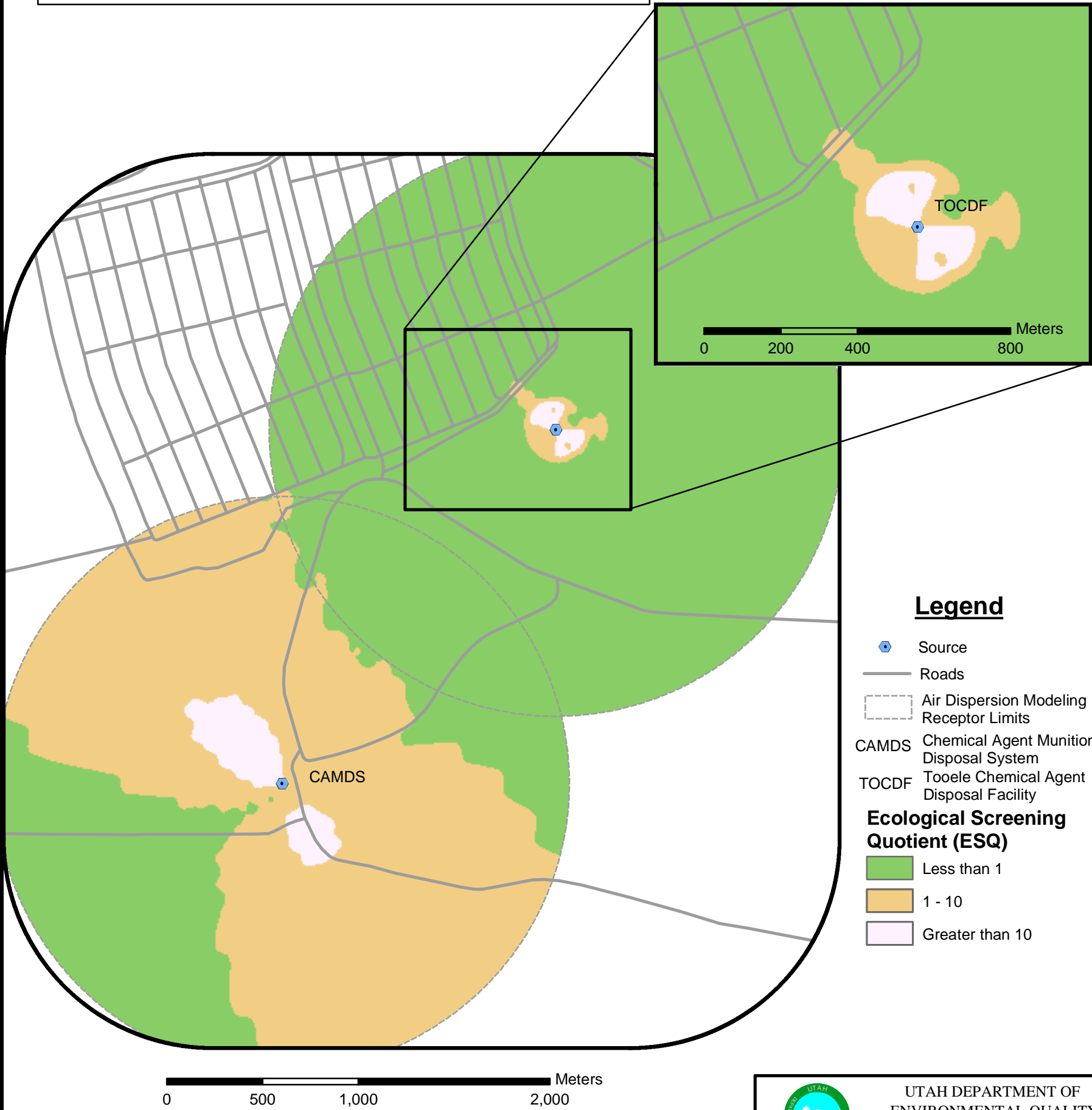
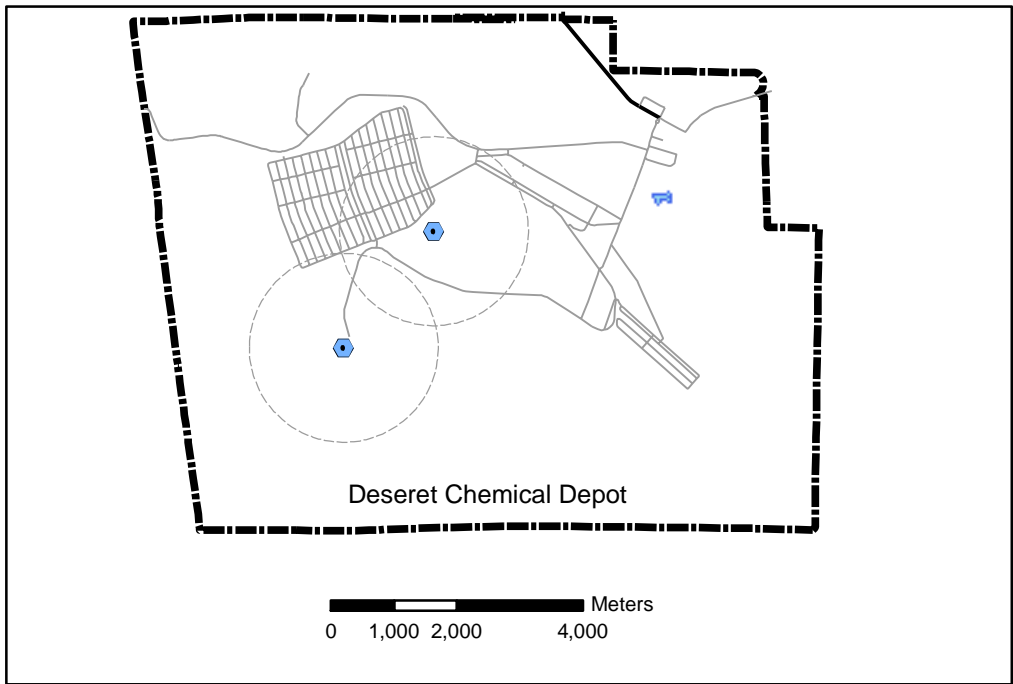
Methylmercury ESQ isopleths for TOCDF were determined using the air dispersion modeling output from the 1.5-kilometer (km) (“near-field”) polar grid centered over TOCDF. Similarly, ESQ isopleths for CAMDS were based on the near-field grid centered over CAMDS. Receptor locations were at 100-meter intervals to 1.5 km from the source stacks arranged every 10 degrees of arc along the circumference at each of the 15 radii. Thus, each grid contained 540 receptor nodes or locations. The isopleths were created in ArcInfo with data exported from the EcoRisk View program into a Microsoft Access database. A query was used to isolate and sum the ESQs based on source stack, COPC, and pathway. The summed ESQs were mapped by coordinate and used to create a virtual 3D surface. The inverse distance weighted (IDW) interpolation method was used to create the surface (Hu undated). The IDW interpolation method is one of several interpolation methods that can be used in ArcInfo.

The ESQ isopleths for CAMDS and TOCDF (summed across sources for each facility) are shown on Figure 4-1. The isopleths indicate that methylmercury in soil is, as expected, greatest near the facilities and the concentration declines with increasing distance from the facilities. Because only the near-field receptors were evaluated, the isopleths could not be extended beyond 1.5 km from the sources. The isopleths indicate that mercury in stack gases emitted from TOCDF deposits relatively close to the source, while mercury in stack gases from CAMDS is dispersed more widely. The differences between the ESQ patterns are believed to stem from different source characteristics, mainly building downwash and, to a lesser extent, stack gas exit velocities. Emission rates and other source characteristics are similar. The isopleths present locations of receptor nodes with ESQs greater than 10, 1 to 10, and less than 1. The isopleths generally indicate that ESQs drop below 1 a short distance from the sources.

For CAMDS, about 54 acres would present ESQs greater than 10, about 1,000 acres would present ESQs between 1 and 10, and about 650 acres would present ESQs less than 1. The geographic extent of the latter two ESQs is unknown because only the near-field receptors were evaluated. For TOCDF, about 9 acres would present ESQs greater than 10, about 18 acres would present ESQs between 1 and 10, and about 1,700 acres would present ESQs less than 1.

## **4.2 EVALUATION OF OTHER SOURCES**

The Jacobs Smelter Superfund site is in Stockton, Utah, which is located near Rush Lake along State Highway 36 (Figure 3-1). The area is almost 10 km north of TOCDF and CAMDS. U.S. EPA performed an ERA at the site to determine potential threats to receptors, including those associated with Rush Lake, from heavy metal releases from former mining and smelter operations at the site (Lockheed Martin 2003).



### Legend

- Source
- Roads
- Air Dispersion Modeling Receptor Limits
- CAMDS Chemical Agent Munitions Disposal System
- TOCDF Tooele Chemical Agent Disposal Facility
- Ecological Screening Quotient (ESQ)**
  - Less than 1
  - 1 - 10
  - Greater than 10

NOTE: ONLY THE NEAR-FIELD DISPERSION MODELING RECEPTOR LOCATIONS WERE USED.

SOURCES: THE STATE OF UTAH DIVISION OF INFORMATION TECHNOLOGY SERVICES AUTOMATED GEOGRAPHIC REFERENCE CENTER, JULY 2000.



UTAH DEPARTMENT OF  
ENVIRONMENTAL QUALITY  
DIVISION OF SOLID AND  
HAZARDOUS WASTE

FIGURE 4-1  
METHYL MERCURY ESQ ISOPLETHS  
SHRUB-SCRUB HABITAT  
OMNIVOROUS BIRDS-  
TERRESTRIAL INVERTEBRATE PATHWAY



**Tetra Tech EM Inc.**

The ERA used food chain models, similar to ones in the SLERAP used in the Phase I ERA, to evaluate risks to several terrestrial and aquatic receptors, including birds that feed on terrestrial invertebrates and those that forage in Rush Lake for benthic invertebrates. The ERA was reviewed to determine whether potential methylmercury risks associated with emissions from TOCDF and CAMDS significantly elevate mercury risks at the Superfund site.

The ERA performed by EPA concluded that risk at the site to terrestrial and semi-aquatic birds appears to be driven by lead concentrations in soil. The report could not conclude that there were no potential risks to terrestrial birds through ingestion of mercury in soil, sediment, and invertebrates. This conclusion was reached because the hazard quotient (HQ) based on the no-observable-adverse-effect level (NOAEL) exceeded 1 and the HQ based on the lowest-observable-adverse-effect-level (LOAEL) was less than 1. The report concluded that there were no mercury risks to semi-aquatic birds foraging in Rush Lake sediment. Lockheed Martin (2003) also reported that sediment samples from Rush Lake contained low numbers of benthic invertebrates and were toxic to benthic invertebrates. The ESQ isopleths presented on Figure 4-1 indicate that methylmercury in stack gas emissions from TOCDF and CAMDS declines quickly as a function of distance, indicating mercury does not pose a risk to omnivorous birds foraging in the Stockton area, almost 10 km from DCD. In addition, the Phase I ERA indicated that methylmercury does not pose a risk to Rush Lake receptors, including benthic invertebrates and semi-aquatic birds, indicating that low numbers of benthic invertebrates and toxic sediments may be the result of other factors, such as dry-down. Based on the information in the Jacobs Smelter Superfund site ERA report and the Phase I ERA results, it was concluded that mercury emissions from TOCDF and CAMDS do not add significant mercury risks to terrestrial and semi-aquatic birds in the Stockton area.

## **4.3 UNCERTAINTIES**

The uncertainty analysis identifies major uncertainties associated with the ESQ estimates and evaluates the significance of methylmercury ESQ values that exceed the target level. Potential risks from VX due to all sources operating concurrently are managed by DSHW through the RCRA permit for TOCDF.

### **4.3.1 Major Uncertainties**

Major uncertainties associated with the risk estimates include those for the three main parts of the risk assessment: (1) estimates of emission rates, (2) exposure assessment, and (3) toxicity assessment. The major uncertainties and the effects on ESQ values are summarized in Table 4-3.

TABLE 4-3

## MAJOR UNCERTAINTIES IN TOCDF PHASE I ECOLOGICAL RISK ASSESSMENT

Major Element of the Risk Assessment	Effect on Ecological Screening Quotient Values		
	Underestimate	Overestimate	Unknown
<b>Emission Rate Estimates</b>			
Evaluation of non-detected COPCs at detection limits		•	
Lack of source-specific trial burn data and the use of surrogate emissions data			•
Use of worst-case emissions rates for CAMDS furnaces		•	
<b>Exposure Assessment</b>			
Use of U.S. EPA-recommended “default” fate and transport parameter values		•	
Evaluation of chronic exposure based on maximum 1-year air concentrations and depositions		•	
Use of available information about ingestion rates			•
Use of watershed and water body input parameters		•	
Lack of fate and transport parameters and exposure factors for COPCs not quantified	•		
<b>Toxicity Assessment</b>			
Evaluation of toxicity based on lowest relevant toxicity reference values available in literature		•	
Lack of toxicity reference values for many compounds	•		

**Notes:**

CAMDS    Chemical Agent Munitions Disposal System  
 COPC     Compound of potential concern  
 TOCDF    Tooele Chemical Agent Disposal Facility  
 U.S. EPA   U.S. Environmental Protection Agency

#### **4.3.1.1 Emission Rates**

The emission rates used in the Phase I ERA were calculated from trial burn data or were extrapolated from trial burn data collected from other sources and other agent campaigns. Oliver and others (2004) compared emission rates for the TOCDF DFS VX campaign, calculated from recently collected trial burn data, to emission rates extrapolated from other sources and campaigns that were used in the TOCDF health risk assessment (Tetra Tech 2002a). The analysis indicated that the extrapolated emission rates were up to three orders of magnitude greater than the emission rates calculated from trial burn data. While additional information is required to determine with more certainty the effect of the use of extrapolated emission rates, the information suggests that the weighted-average and worst-case emission rates used in the Phase I ERA may have overestimated ESQs.

Additionally, COPCs not detected in stack gas samples were assumed to be present at their analytical detection limit. This assumption also generally overestimated ESQs.

For CAMDS, worst-case (among those for the GB, VX, and mustard campaigns) were used to evaluate the potential risks associated with the MPF and DFS. This procedure generally overestimated ESQs.

#### **4.3.1.2 Exposure Assessment**

There are uncertainties associated with several aspects and assumptions of the exposure assessment. The default exposure factors in the SLERAP, particularly the bioconcentration factors (BCF) and food chain multipliers (FCM), tend to overestimate COPC concentrations in food ingested by measurement receptors. The BCFs based on regression models do not account for COPC depuration and FCMs applicable to aquatic food chains are applied to terrestrial food chains and scientific literature indicates contaminants accumulate less in terrestrial food chains.

EELs for receptors were calculated from air concentrations and depositions from the maximum annual average values evaluated over five years. The maximum annual average values are greater than values averaged over five years. The approach may overestimate EELs for wildlife receptors with long life spans.

Ingestion exposures for wildlife were based on food and media ingestion rates calculated from body weights using allometric relationships. The accuracy of the estimated ingestion rates for receptors evaluated in the ERA is unknown.

The calculation of COPC concentrations in surface water bodies was based on equations and parameter values in the SLERAP. The algorithms for calculating water body loading do not account for the loss of surface water runoff to ground water recharge or evaporation before reaching the water bodies, resulting in overestimated COPC loading and overestimated ESQs for surface water receptors.

Several COPCs could not be quantitatively evaluated because of incomplete fate and transport parameter sets and absence of TRVs. These COPCs are predominantly volatile and semi-volatile organic compounds that would be expected to have low persistence in the environment and would not bioaccumulate, and would have low toxicities. While these compounds would expect to present some additional hazards, the risks, however, would be *de minimis* because they are predominantly low molecular weight compounds that would be expected to degrade in the environment.

#### **4.3.1.3 Toxicity Assessment**

Several COPCs could not be quantitatively evaluated because of the lack of toxicity information. As mentioned above, these COPCs are mainly VOCs and SVOCs that would expect to degrade in the environment around the sources. Risks for COPCs with TRVs are generally overestimated because the TRVs reflect the lowest available benchmarks and do not reflect site-specific conditions that tend to reduce COPC bioavailability.

#### **4.3.2 Uncertainties Associated with Methylmercury Risk Estimates**

The procedures used to estimate risk from the treatment of agent at TOCDF and CAMDS are based on conservative or protective assumptions to ensure that potential risks are not underestimated. The effects of these assumptions on the methylmercury risk analysis are discussed below. In addition, the effect of habitat quality on potential risks to aquatic receptors is also discussed below.

#### **4.3.2.1 Uncertainties Associated with Emission Rates**

Emissions of mercury in stack gases from some sources resulted in ESQ values for receptors in shrub-scrub and aquatic environments that exceed the DSHW target level of 1.0. As discussed in Section 4.3.1.1, the mercury emission rates used in the analysis overestimate actual mercury emissions, indicating that elevated ESQs for methylmercury overestimate potential ecological risks.

#### **4.3.2.2 Uncertainties Associated with Fate and Transport Modeling**

The fate and transport of methylmercury was evaluated using U.S. EPA-recommended procedures. The risk assessment evaluates potential exposures to mercuric chloride and methylmercury but the analyses of stack emissions is limited to total mercury. In accordance with U.S. EPA (1999), defined percentages of the mercury released from the stack were modeled as elemental mercury and mercuric chloride. Once the mercury leaves the stack, the fate and transport of the two types of mercury are modeled separately with a portion converting via biological processes to a third type, methylmercury. Methylmercury is the most toxic form of the three types of mercury and the resulting exposures has a considerable amount of uncertainty. Environmental monitoring data suggests that the modeling methods overestimate the amount of mercury deposited in the environment around DCD. No mercury has been detected in fish sampled from Rainbow Reservoir (DCD 2001) and soil sampling results show no accumulation of mercury (Hydrogeologic 2002)

#### **4.3.2.3 Uncertainties Associated with Toxicity**

The calculated methylmercury HQs for avian endpoints were calculated using an NOAEL equal to 0.0064 milligrams per kilogram body weight per day (mg/kg BW-d). The NOAEL was calculated from an LOAEL equal to 0.064 mg/kg BW-d divided by an uncertainty factor of 10 (U.S. EPA 1999). The LOAEL is based on a three generation study with mallards fed a diet with a methylmercury concentration equal to 0.5 mg/kg food. (This was the only methylmercury concentration evaluated in the selected study.) Therefore, the methylmercury dose that actually corresponds to an adverse effect lies somewhere between the NOAEL and LOAEL.

HQs for avian endpoints calculated using 0.064 mg/kg BW-d (the LOAEL) would decrease tenfold. For example, the maximum HQ equal to 19 (listed in Table 4-2) for omnivorous aquatic birds ingesting algae

would decrease to 1.9. In addition, the HQ values slightly greater than 1.0 would decrease substantially below the target level.

#### **4.3.2.4 Uncertainties Associated with Aquatic Habitat Quality**

Elevated methylmercury ESQs for omnivorous birds foraging on aquatic plants and benthic invertebrates in Clover Pond, west of DCD, do not accurately represent potential risks to these populations because the water body periodically dries down, severely reducing available forage. The inherent assumption of continuous foraging activity, therefore, overestimates potential risks to omnivorous birds in Clover Pond.